Bi2212 Superconductors for High-Power Density Motors for Aero Propulsion, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

Future hybrid aircraft, such as NASA's N3-X plan, will require all-superconducting electric motors and generators in order to achieve power density in excess of 10 kW/kg. Unlike the DC rotor, the stator must operate in AC mode, for example, from 0-0.5 T at 120 Hz, making it impossible to use high temperature superconducting (HTS) tapes due to their high losses in transient fields, requiring instead HTS in narrow wire, fine-filament form and cabled into a low-loss transposed form. Our innovation consists of an all-HTS, lightweight high power motor, in which the stator coils are wound with our unique low loss, transposed cables, that is in turn comprised of our novel, strong, low loss, small diameter 2212 wires – not wide tapes, where the wires are sufficiently narrow, have sufficiently fine filaments with enhanced matrix resistances between them, and axial twist for the required low losses in transient field conditions while providing the operating current density and field distributions at 20 K for achieving > 10 kW/kg specific power that has been specified in NASA Subtopic A1.07. As the first step, an optimized, practical design will be developed for an all-superconducting, strong Bi-2212 wire-based machine using a state of the art design approach. As the second step, 2212-based wire and cabled conductor samples for characterization of critical properties will be fabricated in part by building on the results from step one, and also from prior work completed by Solid Material Solutions on reducing ramped field losses in 2212 wires and cables. As the third step, properties of the cables and constituent wires will be tested , including critical current at 20 K and in fields from 0 T to 5 T. As the final step, the results will be utilized to develop a 2212-based conductor, stator and motor design that incorporates features for attaining the target ac loss levels, while also meeting all the other requirements, like strength, Je and manufacturability.

Anticipated Benefits

As loss low ac loss cable, stator windings and stator coils for high specific power, high efficiency motors (to 13 kW/kg) such as those specified for the electric airplane propulsion operating at 20K. Additionally:

*Superconducting bus bar

*Fusion thrusters

*Magnetic shielding

*Magnetic energy storage (SMES)

Significant potential non-NASA commercial applications for this product include:

*High-Field Magnets (> 20 T)

*Ship Propulsion Motors

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Table of Contents

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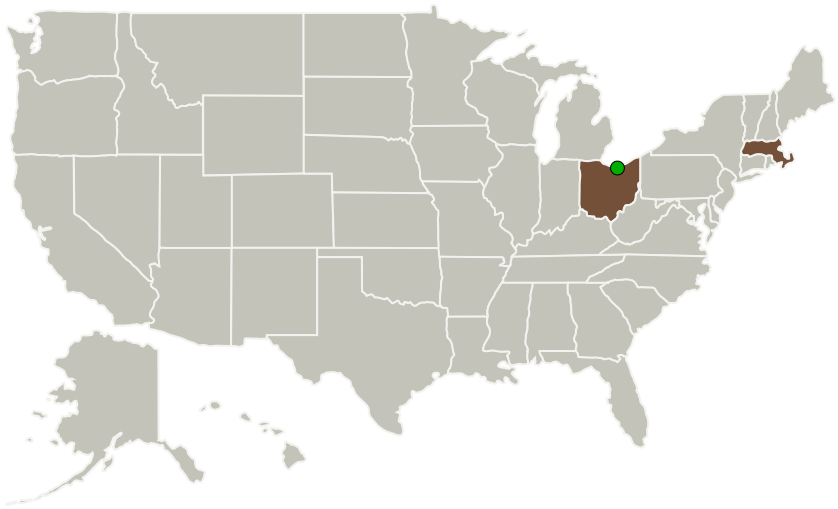
*Ramped field fusion reactor development magnets like the CS coil

*Magnetic energy storage

*Wind power generator

*Accelerator magnets

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Solid Material Solutions, LLC	Lead Organization	Industry	North Chelmsford, Massachusetts
Glenn Research Center(GRC)	Supporting Organization	NASA Center	Cleveland, Ohio

Primary U.S. Work Locations	
Massachusetts	Ohio

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Solid Material Solutions, LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

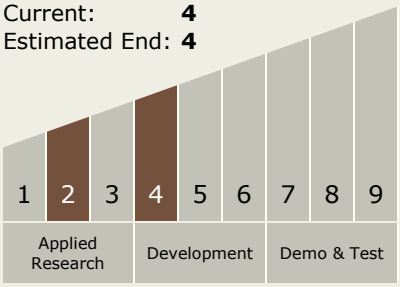
Carlos Torrez

Principal Investigator:

Alexander Otto

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/140949)*

Images

Briefing Chart Image
Bi2212 Superconductors for High-Power Density Motors for Aero Propulsion, Phase I
(https://techport.nasa.gov/image/136439)

Final Summary Chart Image
Bi2212 Superconductors for High-Power Density Motors for Aero Propulsion, Phase I
(https://techport.nasa.gov/image/129328)

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.3 Aero Propulsion
    - TX01.3.9 Hybrid Electric Systems

Target Destination

Earth